

We claim:

1. A monocyclopentadienyl complex comprising the structural feature of the formula $Cp-Y_mM^A$ (I), where the variables have the following meanings:

5

Cp is a cyclopentadienyl system having an aryl substituent,

Y is a substituent which is bound to Cp and contains at least one uncharged donor containing at least one atom of group 15 or 16 of the Periodic Table,

10

M^A is titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum or tungsten or an element of group 3 of the Periodic Table and the lanthanides and

m is 1, 2 or 3.

15

2. A monocyclopentadienyl complex as claimed in claim 1 having the formula $Cp-Y_mM^AX^A_n$ (V), where the variables have the following meanings:

Cp is a cyclopentadienyl system having an aryl substituent,

20

Y is a substituent which is bound to Cp and contains at least one uncharged donor containing at least one atom of group 15 or 16 of the Periodic Table,

25

M^A is titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum or tungsten or an element of group 3 of the Periodic Table and the lanthanides and

m is 1, 2 or 3,

30

X^A the radicals X^A are each, independently of one another, fluorine, chlorine, bromine, iodine, hydrogen, C_1-C_{10} -alkyl, C_2-C_{10} -alkenyl, C_6-C_{20} -aryl, alkylaryl having 1-10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, $NR^{23A}R^{24A}$, OR^{23A} , SR^{23A} , SO_3R^{23A} , $OC(O)R^{23A}$, CN , SCN , β -diketonate, CO , BF_4^- , PF_6^- or bulky noncoordinating anions or two radicals X^A form a substituted or unsubstituted diene ligand, in particular a 1,3-diene ligand, and the radicals X^A may be joined to one another,

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$R^{23A}-R^{24A}$ are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, SiR^{25A}_3 , where the organic radicals $R^{23A}-R^{24A}$ may also

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be substituted by halogens or nitrogen- and oxygen-containing groups and two radicals R^{23A} - R^{24A} may also be joined to form a five- or six-membered ring,

5 R^{25A} the radicals R^{25A} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{25A} may also be joined to form a five- or six-membered ring and

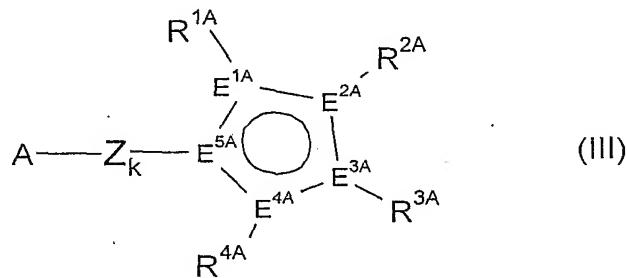
10 n is 1, 2, or 3.

10 3. A monocyclopentadienyl complex as claimed in claim 1 or 2 in which Y is formed by the group $-Z_k$ -A- and together with the cyclopentadienyl system Cp and M^A forms a monocyclopentadienyl complex comprising the structural element of the formula $Cp-Z_k$ -A- M^A (II), where the variables have the following meanings:

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$Cp-Z_k$ -A

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Where the variables have the following meanings:

E^{1A} - E^{5A} are each carbon or not more than one E^{1A} to E^{5A} is phosphorus,

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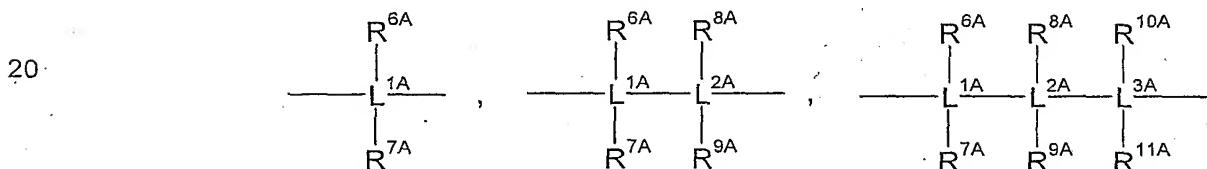
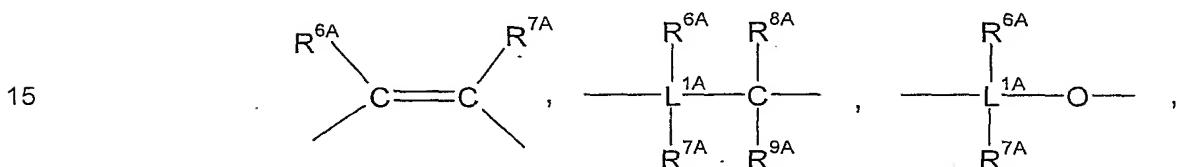
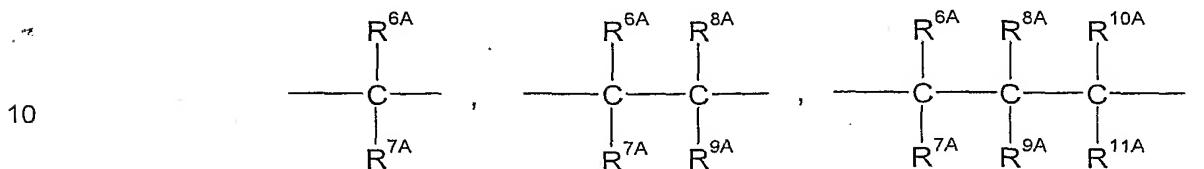
R^{1A} - R^{4A} are each, independently of one another, hydrogen, C_1 - C_{22} -alkyl, C_2 - C_{22} -alkenyl, C_6 - C_{22} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl radical and 6-20 carbon atoms in the aryl radical, NR^{5A}_2 , $N(SiR^{5A}_3)_2$, OR^{5A} , $OSiR^{5A}_3$, SiR^{5A}_3 , BR^{5A}_2 , where the organic radicals R^{1A} - R^{4A} may also be substituted by halogens and two vicinal radicals R^{1A} - R^{4A} may also be joined to form a five-, six- or seven-membered ring, and/or two vicinal radicals R^{1A} - R^{4A} are joined to form a five-, six- or seven-membered heterocycle which contains at least one atom from the group consisting of N, P, O or S and at least one R^{1A} - R^{4A} is a C_6 - C_{22} -aryl, where the aryl may also be substituted by N-, P-, O- or S-containing substituents, C_1 - C_{22} -alkyl, C_2 - C_{22} -alkenyl, halogens or haloalkyls or haloaryls having 1-10 carbon atoms,

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R^{5A} the radicals R^{5A} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{5A} may also be joined to form a five- or six-membered ring,

5

Z is a divalent bridge between A and Cp selected from the group consisting of



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$-BR^{6A}-$, $-BNR^{6A}R^{7A}-$, $-AIR^{6A}-$, $-Sn-$, $-O-$, $-S-$, $-SO-$, $-SO_2-$, $-NR^{6A}-$, $-CO-$,
 $-PR^{6A}-$ or $-P(O)R^{6A}$,
where

L^{1A} - L^{3A} are each, independently of one another, silicon or germanium,

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R^{6A} - R^{11A} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{12A}_3 , where the organic radicals R^{6A} - R^{11A} may also be substituted by halogens and two geminal or vicinal radicals R^{6A} - R^{11A} may also be joined to form a five- or six-membered ring and

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R^{12A} the radicals R^{12A} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, C_1 - C_{10} -alkoxy or C_6 - C_{10} -aryloxy and two radicals R^{12A} may also be joined to form a five- or six-membered ring, and

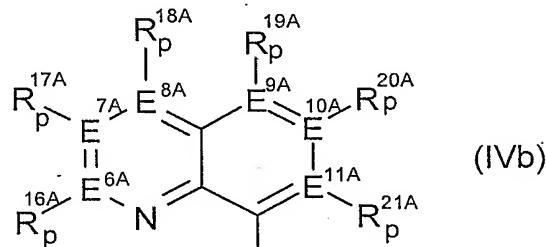
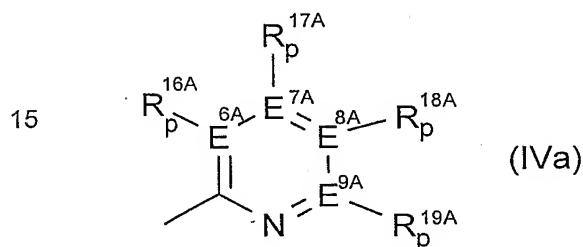
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A is an uncharged donor group containing one or more atoms of group 15 and/or 16 of the Periodic Table of the Elements or a carbene, preferably an unsubstituted, substituted or fused, heteroaromatic ring system,

5 M^A is a metal selected from the group consisting of titanium in the oxidation state 3, vanadium, chromium, molybdenum and tungsten and

10 k is 0 or 1.

10 4. A monocyclopentadienyl complex as claimed in any of claims 1 to 3 in which A is a group of the formula (IVa) or (IVb):



20 , where

E^{6A}-E^{11A} are each, independently of one another, carbon or nitrogen,

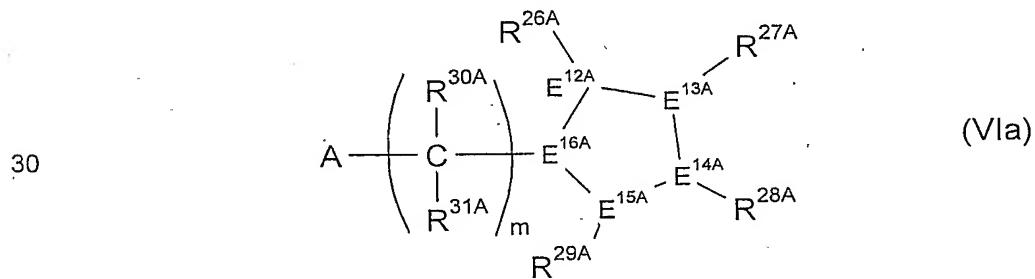
25 R^{16A}-R^{21A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{22A}₃, where the organic radicals R^{16A}-R^{21A} may also be substituted by halogens or nitrogen and further C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{22A}₃ groups and two vicinal radicals R^{16A}-R^{21A} or R^{16A} and Z may also be joined to form a five- or six-membered ring and

30 R^{22A} the radicals R^{22A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{22A} may also be joined to form a five- or six-membered ring and

35 p is 0 when E^{6A}-E^{11A} is nitrogen and is 1 when E^{6A}-E^{11A} is carbon.

40 5. A monocyclopentadienyl complex as claimed in claim 3 or 4 in which -Z-A and the aryl substituent are in the 1,3-positions relative to one another.

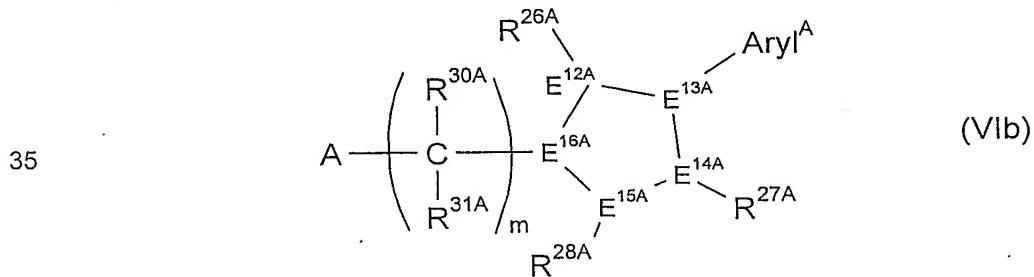
6. A catalyst system for olefin polymerization comprising
- 10 A) at least one monocyclopentadienyl complex according to claims 1 to 5,
 5 B) optionally an organic or inorganic support,
 C) optionally one or more activating compounds,
 D) optionally further catalysts suitable for olefin polymerization and
 15 E) optionally one or more metal compounds containing a metal of group 1, 2 or 13 of the
 Periodic Table.
- 20 7. A prepolymerized catalyst system comprising a catalyst system as claimed in claim 6 and
 one or more linear C₂-C₁₀-1-alkenes polymerized onto it in a mass ratio of from 1:0.1 to
 1:1 000 based on the catalyst system.
- 25 8. The use of a catalyst system as claimed in claim 6 or 7 for the polymerization or copolymeri-
 zation of olefins.
9. A process for preparing polyolefins by polymerization or copolymerization of olefins in the
 presence of a catalyst system as claimed in claim 6 or 7.
- 25 10. A process for preparing cyclopentadiene systems of the formula (VIa),



35 where the variables have the following meanings:

E^{12A} - E^{16A} are each carbon, with four adjacent E^{12A} - E^{16A} forming a conjugated diene system and the remaining E^{12A} - E^{16A} additionally bearing a hydrogen,

- 5 $R^{26A}-R^{29A}$ are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^{32A}_2 , $N(SiR^{32A}_3)_2$, OR^{32A} , $OSiR^{32A}_3$, BR^{32A}_2 , SiR^{32A}_3 , where the organic radicals $R^{26A}-R^{29A}$ may also be substituted by halogens and two vicinal radicals $R^{26A}-R^{29A}$ may also be joined to form a five- or six-membered ring, and/or two vicinal radicals $R^{26A}-R^{29A}$ are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O or S,
- 10 $R^{30A}-R^{31A}$ are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{32A}_3 , where the organic radicals $R^{30A}-R^{31A}$ may also be substituted by halogens and R^{30A} or R^{31A} and A may also be joined to form a five- or six-membered ring,
- 15 R^{32A} the radicals R^{32A} are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{32A} may also be joined to form a five- or six-membered ring,
- 20 m is 0, 1 or 2,
- 25 A is an uncharged donor group containing one or more atoms of group 15 and/or 16 of the Periodic Table of the Elements or a carbene, preferably an unsubstituted, substituted or fused, heteroaromatic ring system,
- which comprises:
- a) reacting an $(A-(CR^{29A}R^{30A})_m)^-$ -anion with a cyclopentanedione or a silyl ether of an enolised cyclopentanedione.
- 30 11. A process for preparing cyclopentadiene systems of the formula (Vlb),



40 where the variables have the following meanings:

$E^{12A}-E^{16A}$ are each carbon, with four adjacent $E^{12A}-E^{16A}$ forming a conjugated diene system and the remaining $E^{12A}-E^{16A}$ additionally bearing a hydrogen,

5 $R^{26A}-R^{28A}$ are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, SiR^{32A}_3 , where the organic radicals $R^{26A}-R^{28A}$ may also be substituted by halogens and two vicinal radicals $R^{27A}-R^{28A}$ may also be joined to form a five- or six-membered ring, and/or two vicinal radicals $R^{27A}-R^{28A}$ are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O or S,

10 $R^{30A}-R^{31A}$ are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{32A}_3 , where the organic radicals $R^{30A}-R^{31A}$ may also be substituted by halogens and R^{30A} or R^{31A} and A may also be joined to form a five- or six-membered ring,

15 R^{32A} the radicals R^{32A} are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{32A} may also be joined to form a five- or six-membered ring,

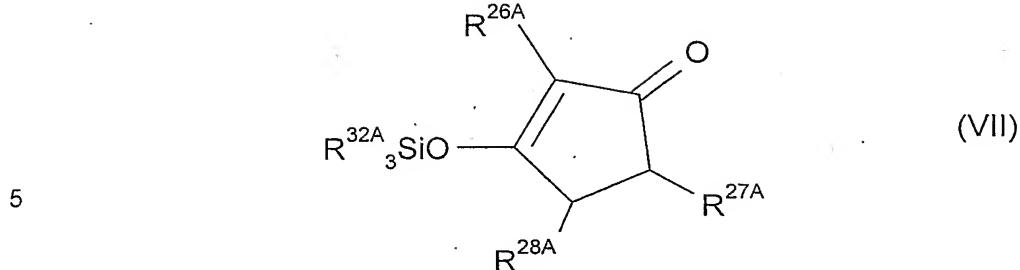
20 $Aryl^A$ is C_6-C_{22} -aryl, for example phenyl, naphthyl, biphenyl, anthracenyl or phenanthrenyl, which may also be substituted by N-, P-, O- or S-containing substituents, C_1-C_{22} -alkyl, C_2-C_{22} -alkenyl, halogens or haloalkyls or haloaryls having 1-10 carbon atoms and

25 m is 0 or 1,

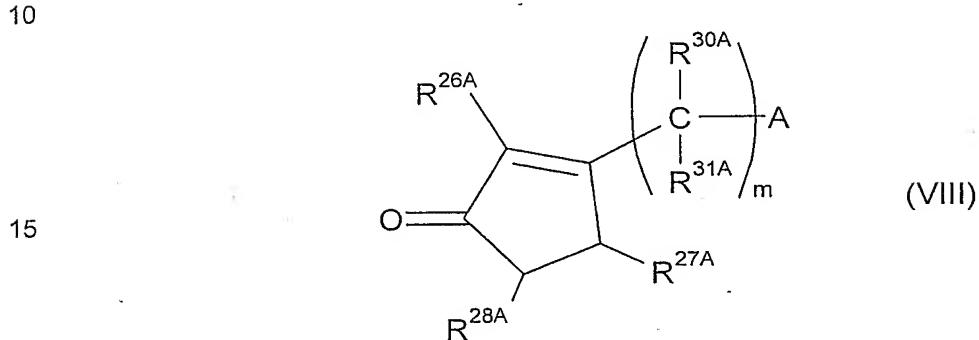
30 A is an unsubstituted, substituted or fused heteroaromatic ring system,

which comprises:

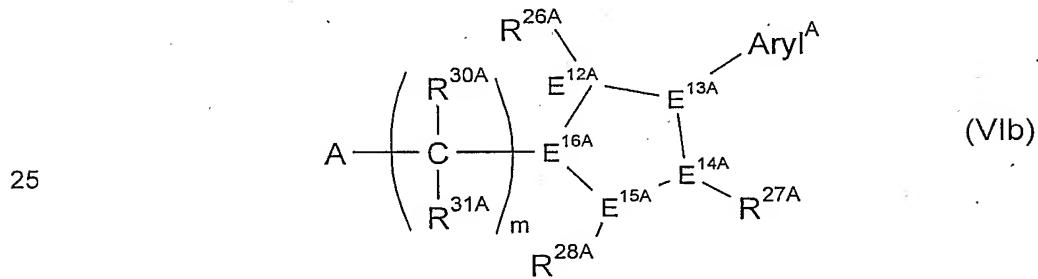
a) reacting an $(A-(CR^{30A}R^{31A})_m)^-$ anion with a cyclopentenone system of the formula (VII)



10 to form a cyclopentenone of the formula (VIII)



12. A cyclopentadiene system of the formula (VIb),
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30 where the variables have the following meanings:

30 E^{12A} - E^{16A} are each carbon, with four adjacent E^{12A} - E^{16A} forming a conjugated diene system and the remaining E^{12A} - E^{16A} additionally bearing a hydrogen,

35 R^{26A} - R^{28A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, SiR^{32A}₃, where the organic radicals R^{26A}-R^{28A} may also be substituted by halogens and two vicinal radicals R^{27A}-R^{28A} may also be joined to form a five- or six-membered ring, and/or two vicinal radicals R^{27A}-R^{28A} are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O or S,

5 R^{30A} - R^{31A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{32A}₃, where the organic radicals R^{30A}-R^{31A} may also be substituted by halogens and R^{30A} or R^{31A} and A may also be joined to form a five- or six-membered ring,

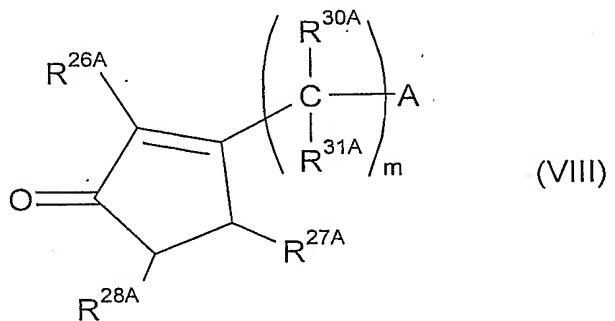
10 10 R^{32A} the radicals R^{32A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{32A} may also be joined to form a five- or six-membered ring,

15 15 Aryl^A is C₆-C₂₂-aryl, for example phenyl, naphthyl, biphenyl, anthracenyl or phenanthrenyl, which may also be substituted by N-, P-, O- or S-containing substituents, C₁-C₂₂-alkyl, C₂-C₂₂-alkenyl, halogens or haloalkyls or haloaryls having 1-10 carbon atoms and

20 20 m is 0 or 1 and A is an unsubstituted, substituted or fused heteroaromatic ring system.

13. A cyclopentenone of the formula (VIII)

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where the variables have the following meanings:

35 35 R^{26A} - R^{28A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, SiR^{32A}₃, where the organic radicals R^{26A}-R^{28A} may also be substituted by halogens and two vicinal radicals R^{27A}-R^{28A} may also be joined to form a five- or six-membered ring, and/or two vicinal radicals R^{27A}-R^{28A} are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O or S,

5 R^{30A} - R^{31A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{32A}₃, where the organic radicals R^{30A}-R^{31A} may also be substituted by halogens and R^{30A} or R^{31A} and A may also be joined to form a five- or six-membered ring,

10 10 R^{32A} the radicals R^{32A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{32A} may also be joined to form a five- or six-membered ring,

15 15 Aryl^A is C₆-C₂₂-aryl, for example phenyl, naphthyl, biphenyl, anthracenyl or phenanthrenyl, which may also be substituted by N-, P-, O- or S-containing substituents, C₁-C₂₂-alkyl, C₂-C₂₂-alkenyl, halogens or haloalkyls or haloaryls having 1-10 carbon atoms and

20 20 m is 0 or 1 and A is an unsubstituted, substituted or fused heteroaromatic ring system.

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